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AN IMPROVED COAL PREPARATION PROCEDURE FOR COKING TESTS

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INTRODUCTION

Modern carbonization plants are described as highly mechanized plants in which the atmospheric pollution and the labour needed are minimized. Their level of complexity, mechanization and automation is comparable to modern petroleum refineries (1,2,3).

In general, pilot plants are used to test a partial or complete process in order to prove its feasibility at the industrial scale. Therefore, they are usually more sophisticated to permit better versatility than their industrial counterparts to allow for testing of present or future technologies.

The carbonization pilot plant at the Edmonton Coal Research Laboratory (ECRL) in Devon provides information about the coking properties of the coals tested. During the process several parameters are controlled in order to provide standard conditions to determine the coking properties of the coal. Some of these parameters are particle size, bulk density of the oven charge, heating rate, coking temperature and coking time. The coal preparation stage for carbonization requires a great deal of physical labor and a large amount of dust is produced providing arduous working conditions for the operators.

The purpose of the present work is to suggest a modified procedure of the coal preparation by using the equipment available with small modifications. It is estimated that these modifications will improve the efficiency of the operation, will reduce air pollution by reducing the dust production, and will minimize the excessive physical labor by increasing the mechanization.

Existing procedure for oven charge preparation is as follows:

1. Three drums of coal (about 409 kg or 900 lb.) are spread on the heated floor when it is available or in the area around the coking oven for drying.

2. When the coal attains a moisture of between 3 to 4% it is transferred back into the drums by means of shoveling.
3. The coal is crushed to obtain the required particle size distribution. This is done in a system which consists of a bucket elevator, hammer crusher, and a splitter. One drum is quartered and then crushed, blended and the screen analysis is carried out; if the particle size distribution meets the requirements (usually 80% - 3.2 mm or 1/8 in.) the other barrels are crushed under the same conditions; otherwise, the crusher speed is changed accordingly.
4. The coal from three barrels is put into a blender for 30 minutes to homogenize the coke oven charge. The blender rotates 14 1/2 revolutions per minute (total 435 revolutions).
5. The coal is transferred back into the barrels and is moved to the coking area where it is put on the floor. A cone is made by shoveling and the bulk density is measured in accordance with the A.S.T.M. standard procedure (5). The bulk density hopper is filled by shoveling the coal into it.
6. If the bulk density is not 770.5 kg/m³ (48 lb./ft.³) the adjustment procedure is carried out. When the bulk density is higher than 770.5 kg/m³ (48 lb./ft.³) water is added to the coal. This is done by spreading the coal on the floor and sprinkling water. The coal is then mixed by shoveling and raking and finally coned. The bulk density is determined again. The procedure is repeated until the proper value is obtained; with luck this only has to be repeated 3 times. In the case of lower bulk density or because too much water was added during the adjustment, the coal is spread on the floor for drying and the whole process is repeated.
7. With the bulk density adjusted to 770.5 kg/m³ (48 lb./ft.³), the coal is weighed and transferred into the charging hopper. This is done by weighing 36.4 kg (80 lb.) of coal in a tray and transferring it into the charging hopper. By repeating this procedure 8 times and adding 13.6 kg (30 lb.) of coal, a total of 305 kg (670 lb.) is transferred into the charging hopper. A grab sample is then obtained to determine the moisture content of the coal.

Suggested procedure for oven charge preparation:

1. This step is the same as step 1 of the actual procedure
2. When the coal contains a moisture of about 2% H_2O it is transferred back into the drums by means of the bobcat and shoveling.
3. The same as step 3 in the actual procedure, however, the lower water content of the coal improves the control of the crushing process (4,6)
4. Same as step 1 in actual procedure.
5. The bulk density of the coal is determined directly in a sample taken from the blender. The blender is stopped and opened to allow enough coal to fill the modified bulk density hopper shown in figure 1. This hopper is exactly the same as the one used in the actual procedure but is mounted on a wheeled, height adjustable assembly. At its lower position the overall height is 95 cm, (37 in.) which allows positioning of the bulk density hopper under the blender. Once filled with the sample the apparatus is wheeled away and its height is adjusted to the higher position which provides the 119 cm (47 in.) height required to meet the A.S.T.M. specifications. Then the usual bulk density determination is carried out.
6. A requirement for this procedure is that the bulk density of the coal should be higher than 770.5 kg/m^3 (48 lb/ft^3). This is expected because of the low moisture content attained in the step 2 (see figure 2). Therefore, the adjustment of the bulk density is done by adding water. In this case the water is added continuously while the blender is in operation. A measured volume or weighed amount of water is put into a cylinder-piston device which is attached to the blender. The piston is connected by means of a quick release connector to a chamber with air under pressure. The other end of the device, is connected to a stainless steel pipe which is introduced into the geometrical centre of the blender. A valve between the pressurized chamber and the piston is then opened so the water is pushed into the pipe that has a spraying nozzle at the end. The blender is put in operation until all the water has

been sprayed into the coal. This process should last for about 5 minutes. In order to ensure homogeneity, the blender is allowed to run 5 to 10 more minutes and the bulk density is determined as in step 5. A diagram of the spraying system is shown in figure 3. If necessary, the process is repeated until the bulk density of the coal is 770.5 kg/m³ (48 lb/ft³). The amount of water added should be carefully controlled so that no excess of water is sprayed into the coal. After a bulk density of 770.5 kg/m³ (48 lb/ft³) is attained, a grab sample is obtained for moisture determination.

7. The coal, with a bulk density of 770.5 kg/m³ (48 lb/ft³), is then transferred from the blender to a weighed drum. The drum plus coal is weighed again and the weight of coal is obtained by the difference. Two or three drums should be used to reach a total of 305 kg (670 lb) of coal. The coal is transferred from the drums into the charging hopper using the barrel mover. A plastic bag can be put inside the drums when the time between the oven charge and the bulk density adjustment is too long; the plastic bag can be closed to prevent water evaporation and thus the bulk density remains constant.

DISCUSSION

The suggested procedure of coal preparation for the coke oven charge presents unquestionable advantages. The efficiency of the operation is increased because it requires less time and two operators can carry out the procedure easily. The present procedure requires three people: two for shoveling and one for raking. It is necessary to emphasize that in the actual procedure the water content of the coal can change during the mixing due to evaporation or absorption of water, thus changing the bulk density of the coal. Consequently, the mixing has to be done in as short period of time as possible to counteract variations of the coal moisture. Moreover, during the transferring of the coal into the charging hopper (see step 7 figure 4) some variation of the coal moisture takes place because of the length of the process producing uncertainty with respect to the bulk density of the coal to be charged.

The suggested procedure prevents air pollution because the homogenization of the coal is done in a closed system avoiding the production

of dust and reducing variations of the moisture of the coal. During the bulk density adjustment of one charge the crushing of the next charge can be done simultaneously. In an emergency situation one person can adjust the bulk density of a particular charge, however for safety considerations it would not be recommended.

The modified procedure is versatile because it also permits the use of other fluids for the bulk density adjustment. At the industrial scale, dried and friable coals, such as Western Canadian Coals, create dust control problems whereas wet coals cause unloading and handling problems because they freeze in cold weather. The agents used for dust and freeze-proofing are oils, calcium chloride, and salt (1). Oils are used for coking coals because they prevent freezing, control dust production, reduce moisture pickup, improve handleability in bins and chutes speeding up charging of coke ovens, and provide better control of the bulk density of the coal charge in the oven. The concentration of oils varies from .2 to 1% (2). This leads to a decrease in bulk density when using dry coals and to an increase when using moist coal. In order to simulate more closely the industrial operations, some experimentation using oils for bulk density adjustment would be beneficial in the coking pilot plant at CRL.

The main disadvantage of the suggested method could be the maintenance of the spraying system in the blender. This can be plugged by coal fines during the blending when there is no water or oil pressure in the lines. Therefore, the system should be easily taken apart for cleaning and several spraying pipes with the respective nozzles should be available. A more detailed diagram of the system can be made if there is a concrete possibility to implement these ideas. Once in operation the new procedure should be tested and compared with the actual procedure in terms of the homogeneity of the coal. This can be done by taking several grab samples at random and doing moisture, screen, and ash analysis in accordance to ASTM standards. It is expected that the new system will improve coal homogeneity, and provide more accurate values of the bulk density of the coal because mechanical blending provides better control on the process (6).

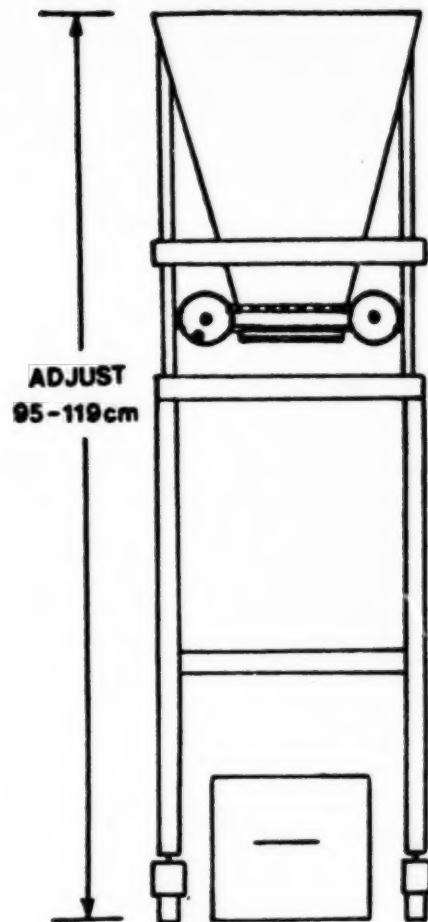
The new procedure requires that every operator should be familiar with the use of mechanical apparatus, such as barrel movers, bobcat, etc. Proper training should be provided in this respect.

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BULK DENSITY HOPPER

FRONT



LEFT SIDE

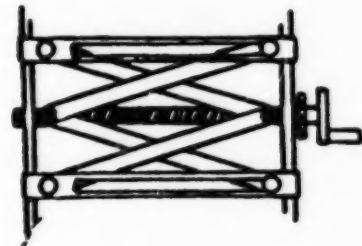


Figure 1

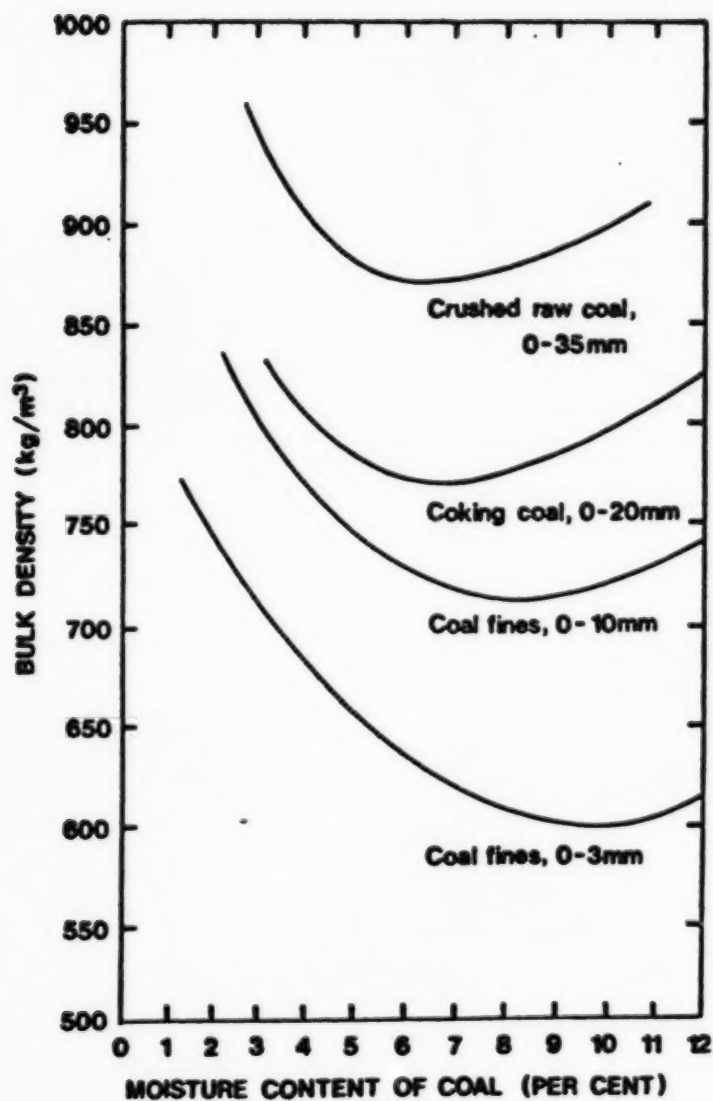


Figure 2. Influence of moisture content and particle size on bulk density. (from Eisenhut, W. in Chemistry of Coal Utilization)

BLENDER

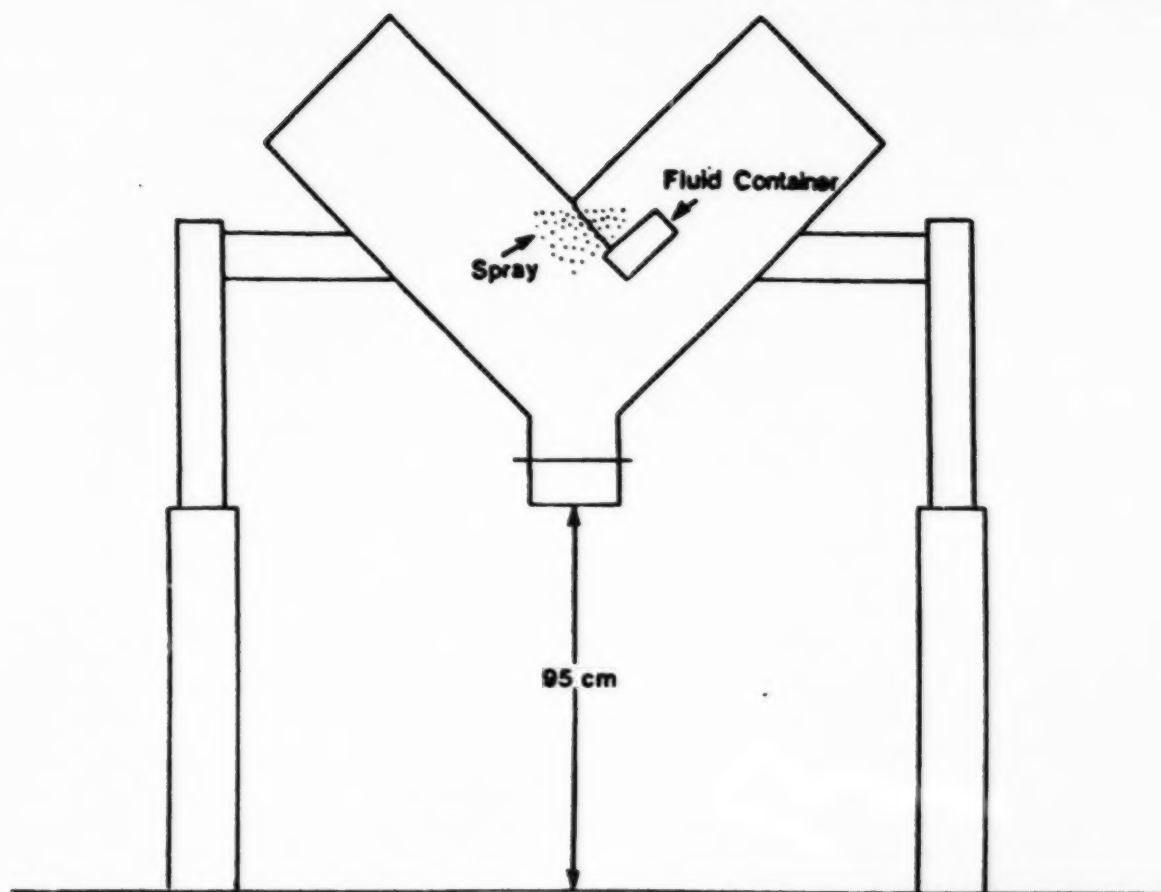
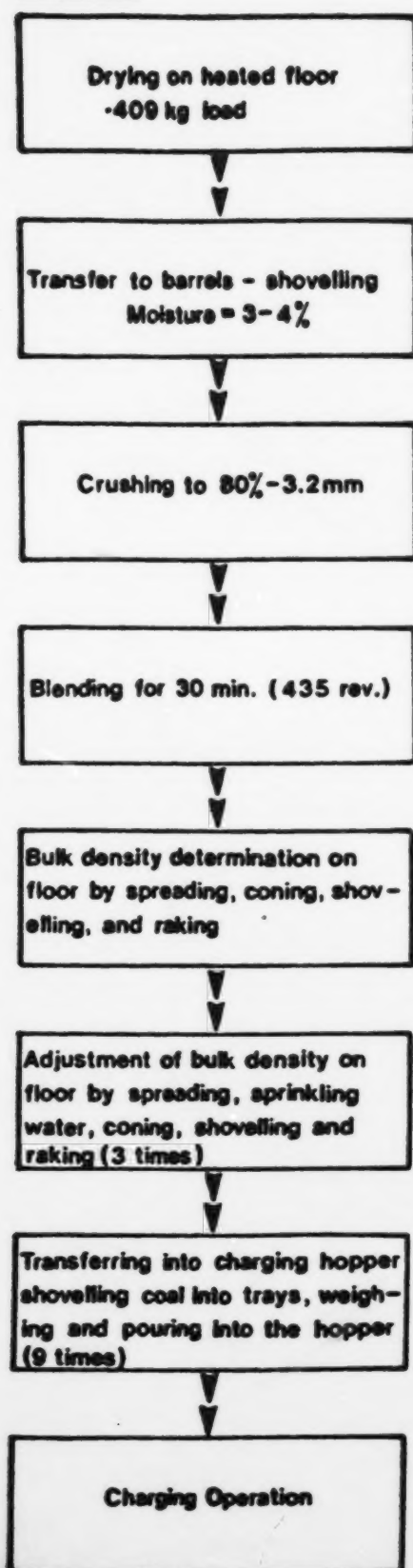


Figure 3

FLOW CHART OF THE ACTUAL AND MODIFIED PROCEDURES FOR COAL PREPARATION OF THE OVEN CHARGE

ACTUAL



MODIFIED

